Claims

[c1] 1.An *in-situ* generation system of fluorine radicals and/or fluorine-containing interhalogen compounds for use in cleaning a processing chamber, said system comprising:

(a)a fluorine source for supplying fluorine gas;

(b)a halogen source for supplying at least one halogen species selected from the group consisting of Cl_2, Br_2, and I_2;

(c)a processing chamber communicatively connected with the fluorine source and the halogen source; and

an energy source for supplying external energy to facilitate generation of fluorine radicals and/or fluorine-containing interhalogen compounds.

[c2] 2.The *in-situ* generation system of claim 1, wherein the fluorine-containing interhalogen compounds have a general formula XF_n, and wherein X = Cl, Br, or I, and n = 1, 3, 5, or 7.

[c3] 3.The *in-situ* generation system of claim 1, wherein the energy source supplies photoenergy.

[c4] 4.The *in-situ* generation system of claim 3, wherein the energy source supplies ultraviolet light.

[c5] 5.The *in-situ* generation system of claim 4, wherein the ultraviolet light has a wavelength in a range of from about 100 nm to about 400 nm.

[c6] 6.The *in-situ* generation system of claim 4, wherein the energy source is selected from the group consisting of hydrogen lamps, deuterium lamps, xenon discharge lamps, electric arcs, discharge tubes, incandescent devices, flash tubes, and pulsed lasers.

[c7] 7.The *in-situ* generation system of claim 1, wherein the energy source supplies thermal energy.

[c8] 8.The *in-situ* generation system of claim 1, wherein the fluorine gas and the halogen species are separately transported into the processing chamber and mixed therein to form fluorine radicals and/or fluorine-containing interhalogen

compounds.

[c9] 9.The *in-situ* generation system of claim 8, wherein the processing chamber is equipped with temperature monitoring and controlling devices.

[c10] 10.The *in-situ* generation system of claim 8, wherein temperature in the processing chamber is in a range of from about room temperature to about 350 ° C.

[c11] 11.The *in-situ* generation system of claim 8, wherein temperature in the processing chamber is in a range of from about room temperature to about 100 ° C.

[c12] 12.The *in-situ* generation system of claim 8, wherein temperature within the processing chamber is in a range of from about 280 ° C to about 350 ° C.

[c13] 13.The *in-situ* generation system of claim 8, wherein the processing chamber is equipped with pressure monitoring and controlling devices.

[c14] 14.The *in-situ* generation system of claim 8, wherein pressure within the processing chamber is in a range of from about 1 Torr to about 1000 Torr.

[c15] 15.The *in-situ* generation system of claim 1, wherein the fluorine gas and the halogen species are mixed before entering the processing chamber.

[c16] 16.The *in-situ* generation system of claim 15, further comprising a mixing chamber upstream of said processing chamber, wherein the fluorine gas and halogen species are mixed in said mixing chamber to form fluorine radicals and/or fluorine-containing interhalogen compounds.

[c17] 17.The *in-situ* generation system of claim 15, wherein the mixing chamber is equipped with temperature monitoring and controlling devices.

[c18] 18.The *in-situ* generation system of claim 15, wherein temperature in the mixing chamber is in a range of from about room temperature to about 350 ° C.

[c19] 19.The *in-situ* generation system of claim 15, wherein temperature in the mixing chamber is in a range of from about room temperature to about 100 ° C.

[c20] 20.The *in-situ* generation system of claim 15, wherein temperature in the mixing chamber is in a range of from about 280 ° C to about 350 ° C.

[c21] 21.The *in-situ* generation system of claim 15, wherein the mixing chamber is equipped with pressure monitoring and controlling devices.

[c22] 22.The *in-situ* generation system of claim 15, wherein pressure in the mixing chamber is in a range of from about 1 Torr to about 1000 Torr.

[c23] 23.The *in-situ* generation system of claim 15, further comprising a holding chamber positioned between said mixing chamber and said processing chamber.

[c24] 24.The *in-situ* generation system of claim 23, further comprising a flow regulating device for monitoring and controlling flow rate of the generated fluorine radicals and/or fluorine-containing interhalogen compounds into the processing chamber.

[c25] 25.The *in-situ* generation system of claim 24, wherein said flow regulating device comprises a mass flow controller.

[c26] 26.The *in-situ* generation system of claim 1, further comprising an exhaust/abatement system downstream of said processing chamber for receiving effluent gas stream discharged by said processing chamber.

[c27] 27.The *in-situ* generation system of claim 1, further comprising at least one bypassing line for flowing the fluorine gas and halogen species, either separately or in mixture, without passing through the processing chamber.

[c28] 28.The *in-situ* generation system of claim 1, further comprising a diluent gas source connected with the processing chamber for supplying an relatively inert gas to dilute the generated fluorine radicals and/or fluorine-containing interhalogen compounds.

[c29] 29.The *in-situ* generation system of claim 28, wherein the relatively inert gas supplied by said diluent gas source comprises at least one gas species selected from the group consisting of Ar, He, and N_2.

[c30] 30.An apparatus for generating chlorine trifluoride for cleaning of a processing chamber, comprising:
(a)a fluorine gas source;
(b)a chlorine gas source;
(c)a mixing chamber communicatively connected with said fluorine gas source and said chlorine gas source, for mixing fluorine and chlorine gases;
(d)a photoenergy source for supplying photoenergy to said mixing chamber to generate chlorine trifluoride therein; and
(e)said processing chamber connected with said mixing chamber.

[c31] 31.An apparatus for generating chlorine trifluoride, comprising:
(a) a fluorine gas source;
(b) a chlorine gas source;
(c) a processing chamber communicatively connected with said fluorine gas source and said chlorine gas source; and
(d) a photoenergy source for supplying photoenergy to said processing chamber to facilitate generation of chlorine trifluoride therein.

[c32] 32.A method for *in-situ* generation of fluorine radicals and/or fluorine-containing interhalogen compounds for use in cleaning a processing chamber, comprising the steps of:
(a)providing a fluorine source for supplying fluorine gas;
(b)providing a halogen source for supplying at least one halogen species selected from the group consisting of Cl_2, Br_2, and I_2;
(c)flowing the fluorine gas and the halogen species into a processing chamber communicatively connected with the fluorine source and the halogen source; and
(d)generating fluorine radicals and/or fluorine-containing interhalogen compounds by supplying external energy using an energy source.

[c33] 33.The method of claim 32, wherein the fluorine-containing interhalogen compounds have a general formula XF_n, and wherein X = Cl, Br, or I, and n = 1, 3, 5, or 7.

[c34] 34.The method of claim 32, wherein the energy source supplies photoenergy.

[c35] 35.The method of claim 32, wherein the energy source supplies ultraviolet light.

[c36] 36.The method of claim 35, wherein the ultraviolet light has a wavelength in the range from about 100 nm to about 400 nm.

[c37] 37.The method of claim 32, wherein the energy source is selected from the group consisting of hydrogen lamps, deuterium lamps, xenon discharge lamps, electric arcs, discharge tubes, incandescent devices, flash tubes, and pulsed lasers.

[c38] 38.The method of claim 32, wherein the energy source supplies thermal energy.

[c39] 39.The method of claim 32, wherein the fluorine gas and the halogen species are separately flowed into the processing chamber and mixed therein to form fluorine radicals and/or fluorine-containing interhalogen compounds.

[c40] 40.The method of claim 32, wherein the processing chamber is equipped with temperature monitoring and controlling devices.

[c41] 41.The method of claim 32, wherein temperature in the processing chamber is in a range of from about room temperature to about 350 ° C.

[c42] 42.The method of claim 32, wherein temperature in the processing chamber is in a range of from about room temperature to about 100 ° C.

[c43] 43.The method of claim 32, wherein temperature within the processing chamber is in a range of from about 280 ° C to about 350 ° C.

[c44] 44.The method of claim 32, wherein the processing chamber is equipped with pressure monitoring and controlling devices.

[c45] 45.The method of claim 44, wherein pressure in the processing chamber is in a range of from about 1 Torr to about 1000 Torr.

[c46] 46.The method of claim 32, wherein the fluorine gas and the halogen species are mixed before entering the processing chamber.

[c47] 47.The method of claim 46, further comprising the step of flowing the fluorine

gas and halogen species into a mixing chamber upstream of said processing chamber to form fluorine radicals and/or fluorine-containing interhalogen compounds.

[c48] 48.A method as in claim 47, wherein the mixing chamber is equipped with temperature monitoring and controlling devices.

[c49] 49.The method of claim 47, wherein temperature in the mixing chamber is in a range of from about room temperature to about 350 ° C.

[c50] 50.The method of claim 47, wherein temperature in the mixing chamber is in a range of from about room temperature to about 100 ° C.

[c51] 51.The method of claim 47, wherein temperature within the mixing chamber is in a range of from about 280 ° C to about 350 ° C.

[c52] 52.The method of claim 47, wherein the mixing chamber is equipped with pressure monitoring and controlling devices.

[c53] 53.The method of claim 47, wherein pressure in the mixing chamber is in a range of from about 1 Torr to about 1000 Torr.

[c54] 54.The method of claim 47, further comprising the step of flowing the formed fluorine radicals and/or fluorine-containing interhalogen compounds into a holding chamber positioned between said mixing chamber and said processing chamber before entering into the processing chamber.

[c55] 55.The method of claim 54, further comprising monitoring and controlling flow rate of the formed fluorine radicals and/or fluorine-containing interhalogen compound into the processing chamber.

[c56] 56.The method of claim 54, wherein said holding chamber is equipped with a mass flow controller.

[c57] 57.The method of claim 32, further comprising the step of flowing an effluent gas stream discharged by said processing chamber into a downstream exhaust/abatement system.

[c58] 58.The method of claim 32, further providing at least one bypassing line for flowing the fluorine gas and halogen species, either separately or in mixture, without passing through the processing chamber.

[c59] 59.The method of claim 32, further comprising supplying an inert gas from a diluent gas source connected with the processing chamber, to dilute the generated fluorine radicals and/or fluorine-containing interhalogen compounds.

[c60] 60.The method of claim 59, wherein the inert gas supplied by said diluent gas source comprises at least one gas species selected from the group consisting of Ar, He, and N_2.

[c61] 61.A method of generating chlorine trifluoride, for cleaning of a processing chamber, said method comprising the steps of:
(a)providing a fluorine gas source;
(b)providing a chlorine gas source;
(c)mixing fluorine and chlorine gases in a mixing chamber communicatively connected with said fluorine gas source and said chlorine gas source;
(d)supplying photoenergy to said mixing chamber from a photoenergy source to generate chlorine trifluoride in such mixing chamber; and
(e)flowing generated chlorine trifluoride into a processing chamber connected with said mixing chamber.

[c62] 62.A method for generating chlorine trifluoride, comprising the steps of:
(a)providing a fluorine gas source;
(b)providing a chlorine gas source;
(c)flowing fluorine gas and chlorine gas from said gas sources into a processing chamber; and
(d)supplying photoenergy to said processing chamber from a photoenergy source to facilitate generation of chlorine trifluoride in such processing chamber.

[c63] 63.A system for generating fluorine radicals and/or fluorine-containing interhalogen compounds, comprising a fluorine source, a halogen source for

supplying at least one halogen species other than fluorine, an enclosure for mixing fluorine with said halogen species other than fluorine, and a photoenergy source for supplying photoenergy to said enclosure.

[c64] 64.The system of claim 63, wherein the fluorine-containing interhalogen compounds have a general formula XF_n, and wherein X = Cl, Br, or I, and n = 1, 3, 5, or 7.

[c65] 65.The system of claim 63, wherein the photoenergy supplied by said photoenergy source comprises ultraviolet light.

[c66] 66.A method for generating fluorine radicals and/or fluorine-containing interhalogen compounds, comprising the steps of providing a fluorine source and a halogen source for supplying fluorine and at least one halogen species other than fluorine, mixing fluorine with said halogen species in an enclosure, and supplying photoenergy to said enclosure from a photoenergy source to facilitate generation of fluorine radicals and/or fluorine-containing interhalogen compounds.

[c67] 67.The method of claim 66, wherein the fluorine-containing interhalogen compounds have a general formula XF_n, and wherein X = Cl, Br, or I, and n = 1, 3, 5, or 7.

[c68] 68.The method of claim 66, wherein the photoenergy supplied by said photoenergy source comprises ultraviolet light.